# THE PROCEEDINGS
*of*
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## IMPRESSIONS OF THE MACHINE TOOL EXHIBITION.

### Address by Sir Herbert Austin, K.B.E., delivered at a Meeting of the Institution, Olympia, London, September 14th, 1928.

SIR ALFRED HERBERT, K.B.E., President of the Institution, who occupied the chair, said that they were present to hear an address by Sir Herbert Austin who had proved himself one of the cleverest designers and producers of motor cars, from the lordly 20-h.p. to the ubiquitous 7-h.p. Sir Herbert had kindly consented to give an address on his impressions of machine tools.

SIR HERBERT AUSTIN said he could congratulate British machine tool makers on the considerable improvement they had made not only in design but also in the line and general good looks of the machines which were exhibited, as compared with the somewhat crude designs that existed a few years ago. The American machine tool builder had been allowed to get a very firm footing in this country in certain classes of machine tools and also in certain of our Colonies, but now the British maker had nothing to be ashamed of. His visit to the States in January of this year gave the impression that American builders of machine tools were, if anything, going backward on the question of quality of design whereas the machine tool builders of this country were certainly going forward. It was to be regretted that some of the larger and best products

of the British machine tool makers could not be exhibited at Olympia for want of space. That difficulty did not arise on the Continent, as those who had been to Leipzig knew. There the Government had assisted in providing facilities for the exhibition of the largest machines and he suggested that the Machine Tool Trade Association in this country should take the matter up with the Government to see if some assistance of this kind could not be obtained. Whilst considerable progress had been made by the British machine tool maker there was still room for a great deal of development. There seemed to be a constant fight going on between the type of machine which carried out all the operations on a particular part and completed it, and the type of machine which carried out only one operation and then passed on the article to another machine for the next operation. There was a large number of the latter type of machine in use in American motor car factories, but which machine was going to come out on top he would not like to say. Possibly there would be a good deal of use made of both types. It was certain that the multiple purpose machine was more complicated and, personally, he was in favour of the simpler type.

### The Question of Co-operation.

One of the things that had always struck him in connection with machine tool building in this country was the want of sympathy between the makers and the users. In pre-war days it was very noticeable how the two did not work in common ; there had been an improvement since, but much still remained to be done. In the days gone by, if a user wanted a special type of machine tool he usually had to design and build it himself and he naturally kept it a secret. It was a fact that the machine tool builders looked askance at that type of work, but that was a position which, whilst it might benefit the individual user, did not benefit the country as a whole. Therefore, he urged that co-operation between the maker and user should be pushed a great deal farther than was the case at present. In the United States, if a manufacturer found himself in a difficulty concerning the machine tools he was using, he would go to one of the leading makers of machine tools and discuss the position with him and a machine tool would be devised to suit the particular case. That was a point which the Machine Tool Trade Association might take in hand so that the special machine tools would be designed and built in the tool makers factories instead of in the works of the user. This was closely associated with the question of machine tool design being in advance of the needs of the user instead of behind. If a machine tool maker in the States saw that a particular problem required solving in a particular industry, he would set to work to evolve a machine for the purpose and would soon

find a good market for it in that particular industry. He did not suggest that some machine tool builders in this country did not do the same, but there was room for a considerable amount of development along those lines.

**Electric Driving and Hydraulic Control.**

One of the special features he had noticed in the Exhibition was the incorporation of electric drive and hydraulic control in the machine tool itself. That was a very noticeable feature at Leipzig, and further improvements in that direction were worthy of considerable attention here because he believed that in a few years time the electric drive, incorporated in the machine tool, would be universal, unless some new method of driving machines could be evolved and at the moment he did not see where that was coming from. In five years time he should say that the majority of machine tools would be driven electrically, the motor being an integral part of the machine. That would result in less costly manufacture on the part of the users and less costly manufacture on the part of the machine tool builders and would obviate the motor having to be stuck on a bit of a bracket, as was so often the case at present. Hydraulic control appeared to be going through a period of trial and he believed in some cases it was looked upon as not being altogether perfect. At the same time, it achieved something which every manufacturer must appreciate, viz., the lessening of the fatigue of the operator, although he was not certain that machine tool makers as a whole were sufficiently alive to the necessity for reducing fatigue on the part of the operator. Machines were tending to be built heavier and more powerful and therefore it was essential that some form of power control should be adopted. Whether hydraulic control would survive or whether the presence of electric motors on the machines would result in the application of electricity for control purposes, he would not like to prophecy, but certainly in many cases hydraulic control was proving very satisfactory.

**Vertical Machine Tools.**

Another tendency was to make machine tools vertical, the object being to take up the least amount of floor space. That had followed from modern methods of line production in which a large number of single purpose machines were used and the part had to be passed on quickly from one machine to another and transport must be avoided, or at any rate economised, owing to the labour cost. Another factor in the same connection was the ability of one man to control a number of machines if they were placed closely together and did not take up a great deal of floor space. There was here an enormous scope for the machine tool builder. Incidentally, he had not noticed any tendency to reduce

prices, and at some of the stands it seemed impossible to get the makers to think in figures less than £2,000.

One of the biggest advances that had been made in British machine tool design was the ability to load up a machine with a new piece whilst the previous piece was going through. In the past it had been necessary for the machine to be standing still before a new piece could be put in, but now a new piece could be put in whilst the machine was operating. In this respect we had advanced anything up to ten times what was being done previously. There was a considerable amount of development required, however, in designing machines suitable for line production where the piece could be put in without disarranging the line method of production and at the same time not stopping the machine.

## Building the Jig into the Machine.

A point in which the American manufacturers were ahead was in building the jig into the machine and not merely taking a standard machine and putting a jig on to it. That required a great deal of attention because he believed it would be the coming practice in which case obviously the design of the framework of the machine would have to be changed to some extent from what it was at present.

Some years ago he addressed a meeting of machine tool builders and made the point that so far as the motor car manufacturer was concerned he wanted machines which were simple and he wanted them at the lowest possible price. Personally, a machine that had fifteen, sixteen or twenty speeds or feeds meant nothing to him because most manufacturers looked forward to scrapping their machines and buying more up-to-date ones. Therefore, they did not want complicated machines, but simple ones capable of doing the particular job. He rather felt that in this country we had suffered because machine tool builders had gone in for complicated all-purpose machines with a large number of feeds and speeds and it was satisfactory to see a change coming about in that respect. For instance, he was pleased with the machine on the stand of Messrs. Alfred Herbert which was of the simplest possible type in itself but was capable of being added to so that it could be worked in two or three stages from a simple machine to a more complicated one. In other words, the machine was a simple one, but it could be added to without altering the design of the machine itself.

## Increased Rigidity.

Again, one could not help noticing, in regard to drilling and milling machines, the increased rigidity of the machines in the Exhibition. The great increase in the output of machines as compared with those in existence at the time of his own apprenticeship—something like ten times the output—was due largely to

the increased rigidity. Even now, however, there was a great deal of room for improvement in this respect and in the future he believed we shall see machines in which the speeds and feeds and cuts will be of very greatly increased dimensions as compared with to-day. He also looked forward to a considerably greater use of ball and roller bearings.

An important direction in which progress is required is in the removal of chips from the machines. We had wonderful machines in which the metal was taken off in the least possible time, but almost as much time was taken in getting the chips out of the mechanism and the tools. Moreover, it was not satisfactory to have the metal dropping about the floor and mechanical engineers would welcome some fairy who would come along and remove the chips. Machine tool makers must pay careful attention to that matter.

### Higher Speeds and Feeds.

Higher cutting speeds and feeds was another direction in which we must look for improvement and these would bring with them the necessity for considerable improvement in the machines themselves. Efforts were being made to produce material that would give the proper impact test, the proper elongation and physical strength with, at the same time, very much higher speeds than we have at present, and therefore it was up to the makers of machine tools to keep ahead of the times and provide machines to handle these new materials.

The matter of price of machine tools he had kept until the last and it was a matter upon which he spoke somewhat feelingly as a user. The price of machine tools to-day, in the opinion of the general manufacturer, was quite on the high side. Prices such as machine tool makers were asking now would, in pre-war times, have been regarded as fantastic. He knew the high prices were largely due to the high cost of labour, but surely there had been considerable advances in methods generally to produce economies which should lead to the hope that some reduction in price might be looked for at any rate as regards some of the machines that had to be used. It would not be to the ultimate advantage of the manufacturers of machine tools who to-day were profiteering—he hoped the word would be excused—because they had a special machine of a particular type which was in advance of others, that they should ask the high prices that were being demanded. It would be a great deal better for the trade of the country if everybody concerned could collaborate to some extent and ensure that a large number of these machines were made and brought into general use. This would result in lower prices and a greater amount of work for the tool makers and the users would be induced to scrap machines long before they otherwise would.

## Discussion.

THE PRESIDENT, in asking for comments upon the address, said in regard to the comments upon the price of machine tools that he had not noticed many machine tool makers, when they died, left very enormous fortunes; he had not noticed any very great speculation in the shares of machine tool making companies; he had not noticed any boom nor had he noticed anything excessive in the way of dividends. He had been asking himself whether, if they made their machines more rigid and more attractive and productive, and re-designed them two or three times a year as would be necessary to keep up with the demand, and at the same time made material reductions in the price, there would be any makers alive at the next Olympia Exhibition. He feared most of them would be dead!

MR. HUTCHINSON suggested that the slow progress which Sir Herbert Austin had rather suggested had been made by British machine tool makers was not altogether their fault, but was due in part at any rate to the very great tendency on the part of big buyers to place the bulk of their orders abroad. The British machine tool maker could now produce machines as good as the Americans, and it was the duty of the user here to assist by placing orders with British firms. If the user in this country would only take the machine tool builder into his confidence he could get exactly what he required. And at the same time we should see the industry here go ahead by leaps and bounds. The question of the individual drive of machine was wrapped up as much with the work of the electrical engineer as with the work of the mechanical engineer. If the machine tool maker was to have a fair chance the electrical engineer must co-operate. Electrical engineers could not be expected to go on making a standard motor standing on four feet and leave the machine tool maker to bear the brunt of designing a machine to fit. The question of special purpose machines was a difficult one in this country owing to the need for making allowance for the flexible state of trade and the possibility of turning the machines over from one class of manufacture to another. Therefore, it might be that some compromise would have to be made as regards the incorporation of loading fixtures in the machines, to which reference had been made. Another direction in which progress was being made was the incorporation of efficient guarding devices in the machines not only to protect the work-people, but also to keep the shops tidy. As an example of increasing rigidity he mentioned a certain vertical spindle planer grinder which a short time ago weighed 3,500 lbs., but which to-day weighs 8,000 lbs. That showed the trend of American design and the realisation in America of the necessity for greater rigidity. The removal of chips might provide a problem for the electrical engineer, because at the moment he failed to see anything other than a

magnetic device likely to prove satisfactory unless it was turning the machine tool through 90° and working it upside down so that the chips would fall away naturally! On the question of prices, it must be remembered that although prices were higher, the capacity of the machines was also many times higher than formerly.

Mr. J. A. Hannay, speaking of multiple spindle or single purpose machines, said that if designers would design complicated pieces then it would be necessary to have complicated machines. With hydraulic control there were not the heavy shocks on the various parts of the machines which sometimes took place and almost seemed that they would knock the machine to pieces. It was the sweet running of the hydraulic control which commended it. Personally, he would rejoice to see the day when there was nothing but electric drives, and if ever the day came when all the spindles had their own motors and were enclosed, it would be a very happy state of affairs. A point he wished to impress upon machine tool makers was that very often a machine would come into the shop of the user, but it would be impossible to get the full output from it for three, six, or even twelve months for the reason that it had been sent out at too early a stage when all the development work had not been completed. The result was that the user had to complete this work at his own cost.

Mr. I. H. Wright, speaking as a machine tool designer, said that Sir Herbert Austin had made two suggestions which were contradictory. The vertical machine was the one which suffered most from swarf troubles and therefore the demand for vertical machines and the abolition of the swarf trouble were mutually antagonistic. There should, however, be no difficulty in devising some magnetic means for removing swarf. As regards ball and roller bearings, the demand of machines in the future would be for some form of roller or ball bearing, but the difficulty was to get a roller bearing with the same close fit as could be obtained with a nicely adjusted conical bearing. What was wanted was some form of roller bearing having the possibility of adjustment. Personal contact was required not only between the user and maker, but between the designer of the machine tool and the man who was in charge of the work ultimately to be done by the tool.

Mr. F. Pollard said that far from being impressed with the simplified design of British machine tools, his own feeling was that machines were getting more and more complicated. For instance, there were in the Exhibition radial drilling machines with thirty speeds and fifteen or sixteen different feeds, but machine tool makers built such machines because they found a market for them in this country. There were very few Austin motor works in this country to encourage the manufacture of single purpose machines and the reason why so many single purpose machines were used in the United States was because of the demand in the large motor

car factories. The only regret he had on returning from a recent visit to America was that we had not, in this country, the same large market for such machines. The Exhibition rather showed that we were getting away from single purpose machines, and it was the fact that our Dominions were asking for machines that would carry out a very large number of operations.

Sir Herbert Austin, replying to the discussion, said he was a little disappointed because he had expected a great deal of criticism. As regards complicated machines, there were a large number bought because the man in charge of the buying had been brought up in an atmosphere which gave him a strong leaning towards multiple purpose machines and he seemed to feel rather more proud of himself if he had a machine which would do every conceivable operation. That had happened in a works in Germany which was building the Austin 7-h.p. car. The man in charge of the tool room had been allowed to buy a lot of complicated machines which had cost 25 or 30 per cent. more than was really necessary for the job with the result that the firm in question was carrying a large amount of unnecessary capital expenditure. A great deal of these purchases was due to the persuasive powers of the machine tool salesman, and he sometimes wished there were as good salesmen in the motor car trade. In conclusion, he again emphasised the necessity for the users and builders of machine tools to get together, not only in the interests of the country as a whole, but in the interests of cheaper production.

The President, proposing a vote of thanks to Sir Herbert Austin for his address, said that the conditions varied so enormously between the requirements of one manufacturer and another that the poor machine tool builder was often at his wits end to know what to do. The only thing to do was to aim at striking a compromise and that was the best that could be done. One subject touched on by Sir Herbert Austin which was particularly interesting to himself was the electric drive. Those who had been to Leipzig must have been struck by the general adoption by the German engineers of the flanged type of motor. He believed that the conditions in the electricity supply industry in Germany were different from what they are in this country. If we were to adopt the flanged type of motor built into the machine—which was a most attractive thing—then we should have to have standard supply and uniform electrical conditions. Electrical engineers would also have to get together and produce standard motors. Sir Herbert Austin, in his business, did not have to meet the consulting engineer, but the machine tool maker did. There were a great many orders placed for machine tools to the specifications of consulting engineers. For example, a certain railway company might order machine tools to the specification of its consulting engineer who would specify that the machines must be equipped

with motors built by Bill Sykes and Co., and that the power must be transmitted by Tom Jones' noiseless chain. The next consulting engineer for another railway company would specify that his machines must be fitted with motors built by Harry Robinson and Co., and that the power must be transmitted by Mr. Richardson's patent laminated belt; somebody else would want direct gearing and somebody else a raw hide belt. . . . The result of all this was, as Sir Herbert had said, that the motors were put upon a bit of a bracket and the machine tool maker was usually very pleased when he found that the bit of a bracket was large enough to take the motor specified. Then there was the large and flourishing business to be done with the electrical engineering firms themselves. The machine tool maker might have standardised on a particular type of motor, but when he got an order from an electrical manufacturing firm, it was but natural that they should refuse to have motors in their works made by another and competing firm, and so out would have to come all the other motors which probably meant an abdominal operation on the machine tool. This did not help towards standardisation, but we must have standardisation and he believed it would come. As to electric drive generally, it was being used to a considerable extent, but it had not yet superseded all other forms. It was true that the percentage of direct driven machines by electric motors was increasing, but there were cases where it was more economical to drive a number of machines off a shaft and to use one motor for the purpose of driving that group of machines. He was particularly interested in hydraulic control, but he was very anxious that we should not be led away by anything just because it happened to be a fashion. He did not know of any business that was more influenced by fashion than the manufacture of machine tools and unless we were careful we should find hydraulic control being used all over the place without any regard to whether it was a sound thing or not. He was watching hydraulic control very carefully, but he had not done much with it yet. In some cases it was undoubtedly delightful, for instance on a grinding machine where there was a heavy table which had to be reversed in a quiet manner and which had to contend with a variable load which was negligible in relation to the load of moving the table. He could not imagine any purpose to which hydraulic control would be better suited, but he was a little doubtful at the moment whether this form of control could be applied to a heavy milling machine. It was rather a remarkable thing that although two or three of the leading American milling machine makers had adopted hydraulic control for heavy milling machines and a good deal had appeared in the Press about this, he had not been able to find any of these machines in the Exhibition. He had seen a number of machines upon which hydraulic control was used for the purpose of reversal of the slides

and adjustment of movement, but he had not seen any machine on which the primary feed was worked by hydraulic control and personally he was not quite sure about it. It seemed to him that it was necessary to get very great perfection in the regulation of the oil supply before hydraulic control could be successfully applied to a machine like a milling machine where the resistance to the cut might vary enormously between the beginning and end. There were certain questions involving the very careful measurement of the oil supply, and the very careful regulation of it, and it was also necessary to be careful not to get air pockets in the oil system or there would at once be introduced an elastic medium and they all knew very well that the one thing to eliminate from machine tools was elasticity.

The vote of thanks to Sir Herbert Austin was carried with acclamation and the meeting closed.

# PROBLEMS OF PRODUCTION WITH SPECIAL REFERENCE TO ELECTRICAL APPLIANCES.

## Abstract of a Paper presented to the Institution, Grand Hotel, Birmingham, September 26th, 1928.

## By A. P. Young

**Fundamental Considerations.**

ALL manufacturing processes can be reduced to the following fundamentals: (*a*) The movement of the requisite raw materials to the manufacturing organisation; (*b*) the movement of these materials through the manufacturing organisation in such manner that the form and shape of these materials can be changed in accordance with a well-defined plan. This involves the use of a machine which is supplied with energy—in modern organisations in an electrical form—so that it can do the work of transformation, the worker thus becoming more and more a tender of the machine; (*c*) the final grouping together of the transformed materials in accordance with plan, to give a resultant unit that is capable of rendering service, and the movement of this unit to its ultimate customer.

It will be observed that the characteristic of each of these fundamentals is movement and, broadly speaking, the efficiency of the manufacturing organisation can be gauged by the rate of movement under (*a*) (*b*) and (*c*), that is, the rate at which the raw materials are moved to the manufacturing organisation; the rate at which the machine, and the worker tending the machine, does work, and the rate at which the final assembly and subsequent despatch of the finished article is consummated.

A simple illustration is the working of an automatic machine. In this case, one material—either steel or brass—is fed into the machine automatically at a uniform rate, and the application of energy to the machine enables the shape of this material to be changed at a steady rate, which ensures the production of simple units which are designed to render service. There we have a steady and automatic flow of the incoming raw material and a steady rate of output of the finished and serviceable unit, whether it be a screw or a nut or other automatic part which subsequently takes up its place as a component of a more complicated and serviceable structure.

**Service.**

The finished units produced on the automatic machine referred to render service, but it is true to say that the service rendered by a screw, for example, is on a somewhat lower plane than that given by a motor car or a gramophone, or even a radio set. There is

necessarily a degree of service and as we ascend the service scale, so the problem of successful manufacture becomes increasingly difficult, due fundamentally to the fact that the design becomes more complex, involving in its make-up the use of many different materials and many more different components.

In this mass production era, success will be measured by the extent to which we are able to increase the ratio of service rendered to simplicity of design. Let me illustrate by citing the case of our newest industry—the radio industry—which only began to assimilate life some five years ago. Those of us who are engaged in this industry, look back with horror on the complexity of some of the earlier designs of valve sets which were put on the market. During the past five years there has been a steady movement in the direction of simplifying these designs and at the same time improving the service rendered.

We live in an age of production. The desire for material benefits is being steadily stimulated, and if this desire is to be completely justified it is necessary that the production of serviceable commodities should be increased by efficient methods, so that a condition of equilibrium may be maintained by ensuring that the increased production is accompanied by an increase in the total productivity of the individual and, therefore, in purchasing power.

The starting point for sound progress in the future is the evolution of designs in which the ratio of service rendered to simplicity of design has been brought to the highest possible figure. This is why the research worker, the development engineer and the designing engineer form a trio of outstanding importance when studied in relation to all production problems, because any improvements in the ratio aforementioned must result in the main from their efforts. The industrial organisation that is going to forge ahead in the years to come is going to be the one that gives proper encouragement to this trinity of workers and at the same time takes steps to ensure that their efforts are allowed to develop and fructify along useful and productive channels.

## The Electrical Industry.

The foregoing remarks have particular bearing on the electrical industry. All manufacture is inherently difficult, for the reason that any piece of well-designed electrical apparatus is first and foremost a sound mechanical structure which has been, so to speak, adapted to perform a definite function. The late Silvanus P. Thomson—probably the greatest teacher in the realms of electrical engineering who has ever lived—made a profound statement many years ago that "sound electrical engineering was ninety-five per cent mechanical engineering plus five per cent electricity." Many present-day teachers and many electrical engineers would, with real advantage to themselves and the rapidly growing industry

which they serve, do well to ponder the fundamental truth of this statement.

All this means that any production problem is concerned first with the manufacture of purely mechanical structure, in which respect it is analogous to the problem that has to be faced in any of the mechanical arts, while in the second place both mechanical and electrical problems have to be dealt with in manufacturing the purely electrical part of the design. This would be bad enough in itself, but the general manufacturing problem is further complicated by the perfectly appalling range of electrical apparatus and devices which it is necessary for any organisation seriously embarking in the electrical industry to manufacture.

There is a fundamental reason for this, brought about by the condition that the utilisation of energy in an electrical form such, for example, as the switching on of a lamp, necessitates a complete series of different complex processes. The stages are: (1) The transformation of the basic energy in coal, fuel or moving water into electrical energy by means of an electric generating machine (the transformed energy takes the form of an electric current); (2) the control of electric energy; (3) the transmission of the electric energy; (4) the reconversion of the electric energy into some other form such as:—(*a*) mechanical energy by means of an electric motor; (*b*) heat energy; (*c*) chemical energy (accumulator); (*d*) electromagnetic waves in the ether (radio).

Each stage in the process has given birth to an industry in itself, which embraces many subsidiary industries. The modern electrical organisation which has as its motto "Everything electrical" must necessarily concern itself with every phase of the problem, with the result that the B.T.-H. Co., which I have the honour to represent, is at the moment controlling a multitude of separate businesses.

The Americans were, indeed, fortunate in the evolution of their electrical industry to get a quick change-over from the oil lamp to the electric lamp. They did not pass through the gas stage as has happened in this country. This fact, coupled with the appalling lack of standardisation in the early stages of the very slow development in this country, has imposed an additional burden on the electrical manufacturing engineer in the shape of a great variety of supply voltages and frequencies. In the U.S.A. practically all the home supply lines are fed at 100-110 volts 50 cycles.

In England, nearly 50 per cent of the homes are fed with direct current at from 100 to 250 volts, while the alternating current supply is 100 to 250 volts at frequencies of 25, 40, 50, 83 and 100 cycles.

This state of affairs will be improved upon as the years roll by, because future developments are all in the direction of standardising 200-250 volts 50 cycles. The great variety of voltages and frequencies at the present time that have to be catered for by any

organisation devoted to the problem of designing and manufacturing electrical appliances for use in the home is, of course, a tremendous handicap, preventing as it does, the full application of mass production principles, and the effect of this handicap is reflected in enhanced manufacturing costs and selling prices.

The famous consulting engineer, Charles Merz, some years ago put forward the somewhat revolutionary, but probably sound, suggestion that it would pay this country to scrap the whole of its existing power stations at a cost of £100,000,000 and erect super-stations to give a uniform voltage and frequency throughout the whole land. He calculated that the improvement in manufacturing efficiency resulting from this change would, in the course of ten years, give such an impetus to electrical development that the initial outlay of £100,000,000 would be amply repaid within that period.

When we ponder on the manifold and intricate problems that daily confront the manufacturing electrical engineer we can sympathise with him to the extent of believing—as he does—that the manufacturing of mere motor cars in quantities is a relatively simple job of the nine a.m. to five p.m. variety.

## Stabilite and its Sphere of Usefulness.

Stabilite is now accepted as the name of a class of vulcanised rubber or hard rubber composite moulding materials more or less modelled on the original Stabalit. The original material was made by Traun, of Hamburg, and used in the production of Bosch magneto distributors, etc. Materials of the Stabilite class in common use to-day are characterised by the fact that they contain from 25 to 30 per cent. of rubber, about 10 per cent. sulphur, selected mineral fillers and pigments. The compounds are specially designed to wear at the same rate as brass, to resist surface carbonisation and have high electric strength and low-current leakage, and be unaffected by moisture, oil, petrol or temperature up to 100° C.

The material is a high-grade insulator having a greater resistance to heat and abrasion and less liability to shrinkage than ebonite. It is usually brown in colour, but is also manufactured with a black finish. It is used principally for magneto distributors, brush holders, slip rings, etc., and also for terminal heads and for miscellaneous high-tension electrical mouldings.

## Synthetic Resinous Moulded Insulation and its Sphere of Usefulness.

Resins of all kinds have been needed in the past to meet the world's requirements—paints, varnishes, lacquers, enamels, stickers and binders, all depend for their existence on a steady flow of resins or uniform qualities. It is not surprising, with our increasing

industrial activity, that supplies of these natural resins were becoming exhausted and fresh sources had to be explored. The present story heralds the activity of research chemists, who have demonstrated that it is possible not merely to equal, but in many cases to improve upon, nature by producing, synthetically, resins having properties greatly desired but not hitherto found in natural products.

The price of natural resins having risen to a very high figure in 1906, Baekeland, of America, commenced a systematic study of these resinous compounds to see if it would not be possible to replace shellac and copals with a synthetic product. His research was not entirely successful, as to this day no synthetic substance has replaced shellac or copal to any great extent. He discovered, however, that by suitably treating phenol with formaldehyde, a resinous product was obtained than on prolonged heating was transformed to a yellow, amber-like solid, infusible and chemically inert, insoluble in any solvents, and therefore useless.

Continuing his researches, he discovered how to control his reactions to enable castings for cigarette holders to be made as a substitute for amber, but the substance was too brittle and expensive to be of any use as a moulding material.

The importance of moulding materials was by this time beginning to be appreciated and shellac was almost universally used. The phonograph was becoming popular and records for this were depleting the already scanty market supplies. Baekeland, therefore, set to work to find a substance which, when mixed with his resin, would give it the desired mechanical strength and cheapness. He found it in wood-meal, and Bakelite was the result.

Curiously enough, another pioneer, Dr. Redman, also of America, working on very similar lines, brought out a patent almost at the same time as Baekeland. Patent litigation ensued in 1916 and this finally led to a consolidation of these competitive interests, and the products of Bakelite, Redmanol and Condensite, which are well known to manufacturers of moulded insulating materials in this country, are now controlled by the Bakelite Corporation of America.

The importance and growth of the industry can best be shown by reference to the output;—In 1921 this was 1,646,000 lbs., in 1922 this was 6,000,000 lbs. and in 1924 this was 12,000,000 lbs., while the growth since 1924 has been still more rapid and amounts to about 24,000,000 lbs. at the present time.

The manufacture of synthetic powders, as they are called, on similar lines is now world-wide. In England we have Moudensite, Formite, Fabrolite and Elo. Their use has become so general as to be almost bewildering. From the motor industry to the radio industry—even to the dressing table—there is hardly a corner where Bakelite does not find a useful home. The ease of moulding, the beautiful finish, the accuracy, durability and cheapness of

articles manufactured, have all contributed to give success to the pioneer work of Dr. Baekeland.

## Textolite Gear Wheels and their Sphere of Usefulness.

Textolite gear wheels are cut from boards or moulded discs of laminated cotton fabric material bonded with fabrolite synthetic resin. The great feature of these gears is that they are silent in operation, they are unaffected by oil or moisture, are strong and wear as well as metallic gears, with which they are commonly meshed. The great advantage of the use of textolite gears is that selective assembly of gears need not be resorted to, and a moderate amount of backlash, can with advantage be allowed without any undue noise resulting. Under proper conditions these gears neither swell nor distort in service, and many hundreds of thousands of them are in use throughout the world for timing gears on motor cars and for a great variety of industrial drives.

In the early part of this lecture the importance of realising the condition, with any line of manufacture, whereby the ratio of service rendered to simplicity of design is brought to the highest possible figure, was stressed.

This is a fundamental factor which, being interpreted, means that a successful business can only be generated and maintained by (1) continually striving to increase the service rendered by the products of the organisation ; (2) continually striving to simplify the design—compatible with the achievement of a desired result, because any such improvement will be quickly reflected in reduced manufacturing costs.

The fundamental idea of service has made tremendous strides in industry in recent years and it is quickly permeating all phases of human endeavour. May the good work continue, because only in this way can the many complex problems still awaiting solution, which bar the road to progress, be adequately and completely solved. All of our industrial problems can be ultimately reduced to a human denominator and unless, therefore, the human unit—no matter what his or her sphere of influence may be—is radiating what might aptly be termed a spirit of service, true progress is not possible. There is abundant evidence to show that the success of a business is dependent on the value which the customer obtains in service per £1 expenditure. The more we can get away from the parochial attitude of mind which thinks in terms of such physical entities as electrical machinery, motor cars and radio sets, and the more we can be brought to realise that we are selling service, the better it will be for ourselves individually, the organisation of which we form a part and, last but not least, the industrial welfare of this country.

And I am thus led right back again to consider the factor simplicity of design—because this is a dominating factor in that both

service and selling price are a function of it. Let us illustrate by considering for a moment the telephone. A quite familar instrument stands on our desk and renders to us service hour by hour and day by day. The magnitude of this service is so great, and it comes to us so easily, that the majority of us quite naturally fail to appreciate its importance.

Two facts emerge from this illustration : (1) The instrument on our desk—transmitter and receiver—is of a standardised design to be seen in all parts of the world. They are all black and we are not much concerned with the fact that the instrument in our home is identical with that used by our neighbour ; (2) the design of the transmitter and receiver have been reduced to bedrock simplicity. In fact, the carbon-granule microphone transmitter, invented by the Englishman Hughes, and the electro-magnetic receiver, invented by the Scot-American Graham Bell, were among the greatest inventions of the last fifty years, because they achieved an astounding result with a minimum number of components.

## Discussion.

Mr. J. A. Hannay, President of the Birmingham Section, who occupied the Chair, said that the problem of production relating to the electrical industry, of which Mr. Young had just given them some idea, was a vast one. It was appropriate that they as production engineers should get this view of the production problems of that great industry.

One of the earlier slides shown during Mr. Young's lecture, which showed 48 per cent for material and 21 per cent for labour, reminded him that a well-known engineer had said that the greatest trouble of the production engineer was on the side of material. They could not get material cheap enough, and there was an enormous field before them in attempting to get material into their factories at a much lower cost. As regards the electrical industry, he agreed with Mr. Young that 95 per cent of its problems were concerned with mechanical engineering. When one sees their work it is sometimes evident that many people who profess to be electrical engineers have little or no mechanical knowledge. Mr. Young had referred to the manufacture of motor cars being simple compared with electrical manufacture. They had had various discussions where the motor car was mentioned and they intended leaving out the subject this session, so he would only say that those in the motor industry were often kept waiting for a little thing like a magneto. Mr. Young had shown a number of magnetos on his slides and had referred to the number of parts in them. In a motor car there are about 1,200 parts in the chassis, and a magneto is only one.

Mr. E. W. Field said he was surprised to hear that there were fifty-nine types of magneto. In view of that fact they certainly

ought to get motor and motor cycle manufacturers to stick to standard types. He was very interested in what Mr. Young had told them about the new lay-out of their radio factory and how the raw material was passed through, also in the research side of their work generally, so important in a firm such as the British Thomson-Houston Company. If it were possible for machine tool makers to group themselves together and found a good research laboratory they might go a long way, also production could not fail to benefit. With reference to certain figures which the lecturer had given, he asked what was the percentage of scrap on magnetos?

MR. YOUNG said that on commercial types the average was 5 per cent. of manufacturing costs. On aircraft types it was much higher.

MR. E. GREGORY asked a question with reference to mould design and whether high-speed steel was used.

MR. YOUNG said that they used ordinary high-speed steel containing 2 per cent of chromium, and had standardised that with success for three or four years. As to mouldings wearing, they must have produced millions to date. They had two moulds working side by side which had been operating continuously for two and a half years.

MR. FIELD: May I ask if the moulds are chromium plated?

MR. YOUNG: They are highly polished, but not plated.

MR. H. C. ARMITAGE said that though Mr. Young called his paper " Problems of Production " he was just a little disappointed to find that all the problems had been solved. At the same time it was most interesting to be told how they had been solved. One thing that struck him was that whereas the motor industry had to rely on other manufacturers for materials, the electrical industry was practically independent of outside materials. It got everything direct, but a hitch in the production of a magneto, for instance, was reflected in the motor industry.

With regard to the fifty-nine types of magneto, were these run side by side or did they switch over from one to another? He would like to know how the girls were paid, as at the present time he was interested in experiments with group piece work. Also, if it were not too much to ask, he would like some information from Mr. Young as to how his costs were arrived at. There did not seem to be a big percentage of machining in the work. Mr. Young had shown them an illustration of a multi-spindle drilling machine. Was that the most highly developed machine, and was it typical of the way in which the magnetos were made?

MR. YOUNG, in reply to Mr. Armitage, said that while they made fifty-nine types of magneto and while these had certain points in common, they were different from each other and all had to be indexed and recorded. He would like to see the motor industry using standardised types. Regarding systems of payment, they

worked on the premium bonus system—fixed wages plus a bonus. They had developed that system to meet their special needs and it worked efficiently. The workers were happy and earned good money. They did not change the piece-work price unless they changed the operation governing the price. Half of the workers in their factory were girls, and in the case of their radio work, 90 per cent. They had paid particular attention to psychological problems. They had a definite colour scheme, ironwork and walls painted blue, while the girls wore blue overalls. The aim was to create an atmosphere beneficial to production, and it was very gratifying to see how the girls responded so well. They were now taking out the ordinary glass windows and substituting Vita glass. As regards costs, these are regularly recorded. A statement comes from the costs department at the end of each month giving costs in each line of apparatus. Mr. Armitage had asked about machines. The whole of their work is handled by special machine tools.

MR. F. NOAKE asked if in assembling so many moulded products there was trouble with ageing and shrinkage.

MR. YOUNG: Not in the case of many of the moulded products. In the case of rubber, this has to be specially cured, and even then it is liable to shrink, though they obviated that as far as possible.

MR. R. H. YOUNGASH said that what the lecturer had told them about the need for selling service had particularly struck him. It is not always easy for men who, for instance, are dealing with motor car parts, to see the connection between their work and the selling of service. All of them should do their best to realise that, whatever their work, it is really service which they are selling.

A cordial vote of thanks for his lecture was passed to Mr. Young, who in the course of the evening illustrated his address with lantern slides, cinematograph, and specimens of apparatus

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†Garnett, J. H., " Glencairn," Warwick Place, Leamington Spa.
Gartside, V., 34, Victoria Street, London, S.W.1.
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Hardaker, S. M., 17, Brownlie Street, Mount Florida, Glasgow.
Harley, H. H., The Coventry Gauge and Tool Co., Ltd., Earlsdon, Coventry.
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*LOCKER, H. S., "Laureston," Sunnycroft Road, Hounslow, Middlesex.
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MELHUISH, M., "Danecroft," Chalk Hill Road, Wembley Park.
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*MITCHELL, R. J., "Homestead," Huntercombe Manor Estate, Taplow.
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MUNN, J. L., 57, Hawkesley Drive, Northfield, Birmingham.
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Quinney, T. G., c/o Burton Griffiths and Co., Ltd., Central House, 76, New Street, Birmingham.

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Rumph, T. S., 71, Tessall Lane, Northfield, Birmingham.

Sacré, A., 17, Chisholm Road, Croydon.
†*Scaife, J. D., Coddington Hall, near Newark, Notts.
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*Shaw, F. W., 32, Ashfield Road, Milnrow, near Rochdale.
†Shaw, P. A., Arden House, St. Paul's Road, Coventry.
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Skipper, C. T., "Melrose," Chapel Lane, New Longton, Preston.
†Smith, N. Gerard, "Birdlip," Orchard Drive, Cowley, Uxbridge.
Smith, S. C., "Ivy Bank," Hart Hill, Luton, Beds.
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Spencer, O. R., "Beechcroft," 48, Russell Road, Hall Green, Birmingham.
Stevenson, D., Glenhurst, Laburnum Road, Maidenhead, Berks.
Stokes, W. E., 70, Mickleton Road, Coventry.
Storey, W. H., Lauriston House, Tavistock Road, E. Croydon.
*Sykes, T.,

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Trott, A. R. V., 28, Chichele Road, Cricklewood, London, N.W.2.
Tryhorn, W., 487, Fox Hollies Road, Hall Green, Birmingham.

VERRIER, W. J., 42, Bridget Street, Rugby.

WALKER, F. W., 80, Frances Road, Erdington, Birmingham.
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COLLINGS, F. S., 51, Cannock Road, Fallings Park, Wolverhampton.
CORDWELL, F. J., 81, Springfield Road, Moseley, Birmingham.
CRUXTON, V. A., 71, Florence Road, Acocks Green, Birmingham.

DALBY, H. F., 79, Dads Lane, King's Heath, Birmingham.
DARBY, W. H., The Woodlands, Woodland Road, Blackheath, near Birmingham.
DAVENPORT, E. H., c/o Vauxhall Motors, Ltd., Luton, Beds.
DAVIES, J. G., Penrhyn, 96, Gillott Road, Edgbaston, Birmingham
DEWHIRST, H., 52, Clifton Place, Shipley, Yorks.
DINSDALE, J., 92, Highlever Road, North Kensington, London, W.10.

ELLIOTT, E. M., 41, Francis Road, Watford, Herts.

FORD, W. W., 17, Lincoln Road, Plaistow, London, E.13.

GARNER, F., The Magadi Soda Co., Ltd., Lake Magadi, Kenya Colony, E. Africa.
GOSSLING, C. E., 68, Wharfedale Gardens, Thornton Heath.

HANNABY, W. A., "Brackenroyd," Burntwood, Buckley, near Chester.
HANNAY, D. A., 57, Howard Road, King's Heath, Birmingham.
HAWTHORNE, T. W., 96, Hugh Road, Coventry.
HOOK, W. C., 107, High Street, Braintree, Essex.
HURST, S., "Devonia," Burman Road, Shirley, Birmingham.

JACKSON, B., 62, Iron Mill Lane, Crayford, Kent.
JOHNSON, M., 107, Hatfield Road, St. Albans.
JONES, J. D., "Lynmouth," Hasilwood Square, Stoke, Coventry.

KELSEY, L. A. J., 36b, Sinclair Road, London, W.14.
KETTLE, G. J., 42, Marlboro' Road, Ealing, London, W.

LEE, F. W., c/o Mr. Anker, Birch Abbey, Alcester, Warwickshire.
LOWE, J. R., "Oaklea," 37, Beanfield Avenue, Coventry.

McLEAN, H. J. G., P.O. Box 176, Temiskaming, Quebec.
McQUILLEN, D., S. A. Fabrica Argentina de Alpargatas, Calle Patricios 1053, Buenos Aires.
MARSH, H. A., 41, Eleanor Road, Hackney, London, E.8.
MARSTON, J. C., 5, The Crescent, Hawtonville, Newark, Notts.
MARTIN, R., 387, City Road, Edgbaston, Birmingham.
MASTERS, W. J., 40, Gresham Street, Coventry.
MATTHEWS, K. H., 57, Curzon Road, Ealing, London, W.5.
MOLLART, A. J., 1, Mount Pleasant Road, New Malden, Surrey.
MONK, G., 61, Highbridge Road, Wylde Green, near Birmingham.

NEWBOLD, B., "Alcantara," Beanfield Avenue, Coventry.
NORTHEY, C. B., 56, Blawith Road, Harrow, Middlesex.

OWEN, J. C., 44, Bath Road, Walsall.

PARES, J., "Janoway," Kendal End, Barnt Green, Birmingham.
PARKIN, C., The Acacias, New Balderton, Newark-on-Trent.
PEARSON, F., c/o W. Sisson and Co., Ltd., Engineers, Gloucester.
†POVEY, H. G., 64, Ingestre Road, Hall Green, Birmingham.
PUCKEY, W. C., 95, Bexley Road, Erith, London.
PUZEY, W. E., Stratton Villa, Newton Street, Newark-on-Trent.

REDDELL, A., 33, Kimpton Road, Luton, Beds.
RENNARD, G., 134, Town Street, Stanningley.
†RICHARDSON, H. T., "Sunnydene," 101, Glendower Avenue, Coventry.
RUMLEY, L., "Nigella," Wainbody Avenue, Green Lane, Coventry.

SALMON, W. H., 23, McLeod Road, Plumstead, London, S.E.18.
SIGGERS, F. E., Hindiyah Barrage, Iraq.
SINHA, S. C., Production Office (Loco), Moghalpura, Lahore, India.
SKINNER, A. C., Copsewood Grange, Stoke, near Coventry.
SLADDEN, C. L., Metropolitan Asylums Board, Mead Works, Carnwath Road, Fulham, London, S.W.6.
SMART, A. R., The De Lavand Free-Wheel Differential, Ltd., Dunham's Lane, Letchworth, Herts.
SMITH, C. M. PEARSON, 10, Queen Victoria Street, Coventry.
SMITH, H. S., 64, Ransom Road, Coventry.
STANDLEY, G. M., 49, Brooklands Road, Hall Green, Birmingham.
STEEL, C. O., Ransome and Marles Bearing Co., Ltd., Newark, Notts.
STILL, G. E., Associated Equipment Co., Ltd., Southall, Middx.
STODDART, T. A., "Inchkeith," Carrington Lane, Ashton-on-Mersey, near Manchester.
STUCHBERY, A. L., 37, Glebe Road. Hornsey, London, N.8.
SUTCLIFFE, W., Hollyoake Villas, Balderton, Newark, Notts.

THACKER, G. A., 72, London Avenue, Radnor, Coventry.
THOMPSON, T. B., 13, University Road, Leicester.
TREGLOWN, G. B., G. D. Petters and Co., Ltd., Windsor Works, Slough.
TRIBE, T. F., Markenfield, Quarry Road, Headington, Oxford.
TUCKLEY, A., 31, Grove Road, Sparkhill, Birmingham.
TYLER, E. H., "The Machinery Publishing Co., Ltd.," 51-52, Chancery Lane, London, W.C.2.

WARD, P., 11, Stanlake Villas, Shepherd's Bush, London, W.12.
WILLETTS, A. P., 48, Woodlands Road, Warley Woods, Birmingham.
WILSON, R., Burn House, Dunlop, Ayrshire.
WOOD, E. G., Hall and Pickles, Ltd., 111, New Street, Birmingham.
WYBRON, A. G., 24, Hugh Road, Stoke, Coventry.
WYNN, A., 34, Barrington Road, Olton, Warwickshire.

YORK, W. D. Colin, Alfred Herbert, Ltd., 25, Victoria Street, London, S.W.1.

## GRADUATE MEMBERS.

ANDERSON, A. K., "Lauriston," Pike Pool Lane, Blackwell, Worcs.
BROWNE, A., 44, Shaftesbury Road, Coventry.
GRAFTON, H., "Glen Leighon," Cyprus Gardens, London, N.3.
HOLDING, W. J., 13, High Street, Clive, Salop.
JACK, J., "Rho-Ness," Douglas Road, Luton, Beds.
MCANDREW, T., Room 1, Block 4, 99 (B) Squadron, R.A.F., Upper Heyford, Banbury, Oxon.
PERKS, C. R., 1, Cannon Street, Cherry Orchard, Shrewsbury.
TAYLOR, M. A., c/o The Y.M.C.A., The Quadrant, Coventry.

## ASSOCIATES.

BEACHAMP, A. E., "Beverley," Upper Hughenden Road, High Wycombe.
DAVENPORT, T. H., 155, Hay Green Lane, Bournville, Birmingham.
FAWCETT, S. G., 41, Landrock Road, Crouch End, London, N.8.
LEFROY, C. B. H., c/o The Rover Co., Ltd., Meteor Works, Coventry.
POULTNEY, S. L., M.B.E., "Ulramas," 66, Princes Avenue, Watford.
POULTNEY, S. V., "Ulramas," 66, Princes Street, Watford.
PURI, Y. R.
SINHA, J. M., Thos. Cook and Sons, Berkeley Street, London, W.1. (A-3 Premnagar, P.O. Dayalborgh, Agra, India).

## AFFILIATES.

ANDREWS, A., Messrs. Burton, Griffiths and Co., Ltd., 64-70, Vauxhall Bridge Road, London, S.W.1.
ARCHDALE, F., Messrs. James Archdale and Co., Ltd., Ledsam Street, Birmingham.
COLEMAN, E. W., Messrs. Gordon and Co., Taunton Road, Sparkbrook, Birmingham.
HARTLEY, N. R., Associated British Machine Tool Makers, Ltd., Daimler House, Paradise Street, Birmingham.
JONES, R. A., Messrs. Joseph Lucas, Ltd., Gt. King Street, Birmingham.
LLOYD, A. H., Messrs. Alfred Herbert, Ltd., Foleshill, Coventry.
NORMANSELL G. W., Messrs. Joseph Lucas, Ltd., Gt. King Street, Birmingham.

Orcutt, A. H., Messrs. Gear Grinding Co., Ltd., Handsworth, Birmingham.

Thompson, G., Messrs. H. W. Ward and Co., Ltd., Dale Road, Selly Oak, Birmingham.

## AFFILIATED FIRMS.

Archdale, James and Co., Ltd., Ledsam Street, Birmingham.

Associated British Machine Tool Makers, Ltd., Daimler House, Paradise Street, Birmingham.

Burton Griffiths and Co., Ltd., 64-70, Vauxhall Bridge Road, London, S.W.1.

Gear Grinding Co., Ltd., Handsworth, Birmingham.

Gordon and Co., Taunton Road, Sparkbrook, Birmingham.

Gordon England, E. C. and Co., Ltd., Palace of Industry, Wembley.

Herbert, Alfred, Ltd., Foleshill, Coventry.

Lucas, Joseph, Ltd., Gt. King Street, Birmingham.

Ward, H. W. and Co., Ltd., Dale Road, Selly Oak, Birmingham.

## HONORARY MEMBERS.

Herbert, Sir Alfred, K.B.E., Dunley Manor, Whitchurch, Hants.

Meston, J. M., Priory House, Priory Street, Coventry.

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